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Abstract: The ruddy duck (*Oxyura jamaicensis*) was introduced to wildfowl collections in the United Kingdom (UK) in the 1940s and subsequently escaped into the wild. Estimated numbers have increased rapidly in the UK from 20 wintering birds in 1962 to 5,946 in January 2000. As the population of feral ruddy ducks in the UK rose, so did the number of records of ruddy ducks on the European mainland. In 1984, ruddy ducks were first recorded in Spain, which is home to internationally important populations of the rare indigenous white-headed duck (*Oxyura leucocephala*). By 1991, hybrids resulting from crosses between the two species were recorded in that country. The two species hybridise readily, with the ruddy duck apparently possessing the competitive advantage. The ruddy duck is now recognised as the most significant threat to the white-headed duck and the UK appears to be the main source of birds reaching mainland Europe. This paper details the development of a control and then an eradication programme for this species in the UK.

Key Words: invasive species, non-native, *Oxyura*, ruddy duck, United Kingdom, white-headed duck.

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INTRODUCTION

The control of established non-native species provides a range of practical, political and logistic problems. The United Kingdom (UK) has a history of eradicating invasive non-native terrestrial vertebrates such as the coypu (*Myocastor coypus*), muskrat (*Ondatra zibethicus*), and porcupine (*Erethizon dorsatum*) to protect farming and commercial interests (Gosling and Baker 1989). This paper describes the control and ongoing eradication programme directed at the North American ruddy duck (*Oxyura jamaicensis*) in the UK. This is an unusual programme given that the target is a bird and effort is spread throughout the UK. It is also unusual that the motive is to protect international biodiversity and, in particular, the status of the white-headed duck (*Oxyura leucocephala*) in Spain. The ruddy duck programme has evolved through a number of discrete stages, each with separate political, economic and practical constraints. This paper details the development of this project, and the process by which the methods and costs have been refined to produce the current eradication programme.

THE WHITE-HEADED DUCK

The white-headed duck is the only stiff-tail duck indigenous to Europe. In the breeding season, it is largely confined to freshwater or brackish, alkaline, eutrophic lakes. Breeding sites are small or enclosed in areas within larger wetland systems. They are typically shallow and fringed with dense emergent vegetation which holds the nest sites. Wintering sites are generally larger, deeper and often have little emergent vegetation. The principal food source is chironomid larvae but a variety of other invertebrates, seeds and plants are eaten (Green and Hughes 2001).

(a) The only European breeding population occurs in Spain, where it is strictly protected. Numbers of white-headed ducks in Spain have risen from 22 in 1977 to 2,600 in early 2003 following the introduction of measures to protect their habitat and a ban on hunting of the species. Over 82% of breeding and wintering white-headed ducks in Spain occur on protected sites.

THE INTRODUCED RUDDY DUCK

The ruddy duck is a native of North America and Central America, and the northern part of South America. In its native range, it is common, with a stable population of over 500,000 (Wetlands International 2002). It breeds in emergent

vegetation on eutrophic water bodies of all sizes. Outside the breeding season, it tends to occur in large flocks on larger water bodies, particularly artificial reservoirs in the UK. In its native North America, very large numbers winter off the coasts of the United States and Mexico but birds are only very rarely observed under these conditions in the UK.

Over the last 50 years, ruddy ducks have established a feral population in the UK and are now beginning to colonise other north-western European countries. A small number were brought to the UK and introduced into waterfowl collections in the 1940s. However, approximately 70 individuals escaped or were released in the 1950s, allowing the establishment of a feral population. By January 2000, the UK population was estimated at 6,000 birds (Wetlands Advisory Service 2002). In 1965, the first European record of a free-flying ruddy ducks outside the UK was reported.

Outside the UK, there is only one other European country which could be considered to have a self-sustaining population of ruddy ducks at present (France), although annual breeding attempts have occurred for a number of years in Ireland and the Netherlands. Even so, numbers of breeding birds in all of these countries remain very low compared to numbers in the UK, which still holds over 95% of the total European population. Hughes et al. (2004) estimated that France has around 20 breeding pairs and the Netherlands 4-7 breeding pairs. In Ireland (excluding Northern Ireland), there have been only four confirmed breeding records since 1992. However, breeding is probably more regular than this suggests. No other European countries have regular (annual) breeding records for ruddy ducks, although many countries have occasional records.

It is still highly likely that immigration of ruddy ducks from the UK to France, the Netherlands, and Ireland is occurring. For example, peak winter counts in France recorded almost 200 birds in 2003-2004 (Hughes et al. 2004) but there are only an estimated 20 breeding pairs during the summer. The increase in the UK population has been highly correlated with the increase in records for continental Europe, even to the extent that the number of continental records was lower in years following short-term declines in the UK population (Hughes et al. 1999). It is believed that all ruddy ducks (both feral and captive) in Europe are descended from the few birds imported into the UK in the 1940s. These birds have a low genetic variability compared to wild birds in their native range. DNA analyses of ruddy ducks shot in Spain, France, and Iceland strongly suggest that these individuals do not originate from North America because of their low genetic variability. The DNA fingerprints of these birds were, however, very similar to captive and feral ducks from the UK.

Ruddy ducks have now been recorded in 23 Western Palearctic countries with breeding records in at least 11, and regular breeding attempts in five (France, Ireland, Morocco, Netherlands, and the UK).

HYBRIDIZATION

Genetic research (McCracken et al. 2000) shows that ruddy and white-headed ducks are separate species which have been geographically isolated without any gene flow for between two and five million years. In 1982, ruddy ducks were first recorded in Spain and this species has now been recorded annually since 1991. At least 139 individuals have been recorded in a minimum of 43 different locations in Spain. Despite an active and well-organised control programme to cull ruddy ducks, 59 hybrids have been recorded on at least 23 sites (Hughes et al. 1999). The mating strategies of the two species are distinct and the male ruddy duck has an apparent mating advantage over the male white-headed duck. Male ruddy ducks are not territorial, but rather defend “revolving territories” around their mates. Unpaired males attempt persistently to mate with females of both their own and other species. Forced copulation by one or more males on lone females is common (Gray 1980). In contrast, male white-headed ducks form hierarchies, with dominant males forming stable pair bonds with one or more females (Torres et al. 1985) and defending territories of emergent vegetation (Amat and Sanchez 1982). In captivity, ruddy duck x white-headed duck hybrids are fertile to at least the third generation.

There is a degree of uncertainty about how the genetic dynamic between the two species would develop if larger numbers of ruddy ducks were allowed to reach Spain. However, given the aggressive and promiscuous mating strategy of the ruddy duck, the extent of hybridization is likely to increase.

THE DEVELOPMENT OF RUDDY DUCK CONTROL IN THE UK

The Feasibility Study 1993-1996

In 1993, a project was commissioned to undertake small-scale research into the feasibility of control, using a variety of methods. This project, costing £104k ($208k), was carried out by the Wildfowl and Wetlands Trust (Hughes 1996). The project found that breeding season shooting was the most effective method of control, followed by winter shooting from the bank. Egg-oiling and nest-trapping of females were also successfully carried out, but these methods proved less effective than shooting. The conclusions drawn from this work were that eradication was feasible, but that larger scale control was required to more fully define the timescale and costs involved.

The Regional Control Trial 1999-2002

The Ruddy Duck Regional Control Trial was established in April 1999 and ended in May 2002. The full report is available on the web (www.defra.gov.uk/wildlife-countryside/scientific/ruddy/ruddy1/Fullreport.pdf). This trial set out to determine the feasibility, costs and access requirements necessary to control the UK ruddy duck population. The project employed a project manager together with six control officers, although not all of these worked full-time on the project. Control was primarily through the use of firearms, principally Remington .223 rifles and five-cartridge semi-automatic 12-guage shotguns, although traps were also used to capture birds for humane dispatch on a sample of sites. Shooting was conducted both from the shore and from boats, with small teams operating independently through most of the breeding system, but with all of the control officers working together on the larger wintering sites.

Three regions were selected to represent different challenges representative of the national situation. On Anglesey (a rural island on the north coast of Wales) and in the Western Midlands (a heavily populated region in central England), control took place year-round, while in Fife (a rural county in Scotland), it was limited to the autumn and early winter. These areas are believed to have held around 15% of the UK population (900 birds) at the time the trial began.

Permission from landowners to carry out control of ruddy ducks was sought on a voluntary basis for 153 sites. These sites had 193 owners/occupiers which had to be approached. Of the 193 owners and occupiers contacted, 58% gave permission for the control of ruddy ducks. Permission to carry out control was granted for 52% of the 153 sites. Control by shooting was allowed on 48% of all sites, with control by trapping on an additional 4%.

The UK ruddy duck population in January 2000 had been estimated at 6,000 birds, with a 95% confidence interval from 5,407 to 6,733 (Wetlands Advisory Service 2002). We culled 2,651 ruddy ducks over the three years, although the project was suspended for four months in 2001 during the Foot and Mouth Disease outbreak. The total included 751 females, 1,137 males and 763 immature birds.

On Anglesey, our aim was to reduce the breeding population by a minimum of 70% within three years. The original breeding population of 200 birds was reduced by over 70% within the first twelve months of the trial and by an estimated 93% within sixteen months. In the Western Midlands, the aim was to reduce the immediate pre-breeding population by the maximum amount possible. Counts on a sub-set of 17 sites showed reductions of 28% in the first twelve months. Counts on a sub-set of 23 sites showed a further 54% reduction in the second twelve months of the trial. These figures represent an overall reduction of 66% in the first two years of the trial. Our aim in Fife was to kill the maximum number of the postbreeding (autumn) population. We removed 216 ruddy ducks in Fife during the trial: 33 in 1999, 163 in 2000, and 20 in 2001.

Control during the breeding season was carried out by shooting on both Anglesey and in the Western Midlands. We made 249 control visits at this time of year and 847 ruddy ducks were shot (32.0% of the total number of ruddy ducks killed during the trial). Control of birds early in the breeding season, especially of adult females, is important to minimize the numbers of young birds hatched. It is more efficient early in the season as by late-May more cover is available for both sexes and the females begin to spend a large part of their time sitting on eggs and are thus more difficult to shoot. Typically, field officers worked in pairs at this time of year and most birds were shot from the bank with either a .223 rifle or a shotgun. On average 47% of the ruddy ducks present on breeding sites were killed per visit with a staff input of 2 hours on site per bird killed.

The much reduced ruddy duck numbers on Anglesey during the 2000 breeding season allowed an assessment of the likely time requirements when dealing with very low numbers of birds. The count information from Anglesey suggested that reduced numbers of birds are not distributed across all the

potential breeding sites. Rather, the birds appear to concentrate in the best breeding habitats in an area. In the case of Anglesey, we found ruddy ducks on around 12 sites in June 1999, with estimated population of adult birds of about 100. The average amount of staff time on site per bird killed (53 in total) was 1.0 hours during this period. In June 2000, counts suggested birds were present on only seven sites for most of the month, and the population varied between 14 and approximately 30. During this period, the average staff time per bird killed (14 in total) was 4.2 hours. Around half of this difference is due to the higher number of visits in 2000 when a visit was made for the purpose of control but either no birds were seen (although they were believed to be present) or no opportunity arose and no shots were fired.

Post-breeding (autumn) control by shooting was carried out in all trial areas while winter control was carried out in the Western Midlands and Anglesey. We shot 1,787 birds (67.4% of the total number culled) at this time of year on 17 sites. Four to six field officers were usually involved and the ducks were either herded towards guns on the bank by means of a boat or, on the larger waters, shot from the boats themselves. With only a few exceptions, shotguns alone were used at this time of year. On post-breeding and wintering sites 1 km^2 or less in extent, 54% of birds present were shot per visit on average, with a staff input on site of 1.1 hours per bird killed. On larger waters the percentage of birds killed was reduced (mean 19%), but the staff input on site was only 0.8 hours per bird.

Three traps were constructed at three post-breeding/wintering sites and fourteen traps on three breeding sites. Approximately 900 hours of staff effort in construction, maintenance and driving of ducks during the autumn and winter failed to result in any captures during this period. During the breeding season, approximately 750 hours of staff effort in construction and checking of traps resulted in a total of 17 ruddy ducks (five females and twelve males) being caught on one of the three sites. The results of this work suggest that post-breeding and winter trapping is ineffective with this species, but that breeding season trapping, although much less efficient than shooting, may be effective on certain sites.

We shot six non-target species during the regional trial. Three non-target ducks were shot in error. The remaining three incidents involved a swallow (*Riparia* spp.) and two coots (*Fulica atra*) flying into the line of fire. Additionally, a coot was killed by a dog collecting ruddy duck carcasses. These seven non-target casualties during shooting operations compare to 2,634 ruddy ducks shot, a non-target percentage of less than 0.3. During trap testing in spring 2002, seven young mallard (*Anas platyrhynchos*) chicks were killed when they became trapped in netting. A black-headed gull (*Laris ridibundus*) carcass was found floating in one trap although the circumstances of its death are unclear as the trap was open at the time and, having no roof, the bird should have been able to escape. This figure of eight non-target casualties compares to 17 ruddy ducks caught, resulted in a non-target kill of 47%.

A stochastic Monte Carlo simulation model was constructed to project the national ruddy duck population from January 2000 under a variety of control strategies. Three variables were included; efficacy per person (by how much each member of staff could reduce the national population by per year), numbers of staff, and changes in ruddy duck population growth rate. There could be as many as 1,000 breeding sites nationally, but it is access to 40 or so key post-breeding and wintering sites which will be critical to the acceptable progress of an eradication scheme. If this were available, modeling suggested that there was an 80% certainty that the population could be reduced to fewer than 175 birds in between four and six years, at a cost of between £3.6m and £5.4m ($7-11m) (Smith et al. 2005)

The final report on the control trial was published in July 2002. In March 2003, the Minister responsible for nature conservation and biodiversity announced that eradication of the North American ruddy duck from the UK was the Government's preferred outcome. In confirming this decision, the Government also concluded that further research work into control techniques was still required, that the protection provided by domestic legislation should be removed, and that action by other European countries was also required to remove the threat from the ruddy duck.

National Control Trials 2003-2006

Following the regional control trial, work continued to refine and improve methods, to extend the work to a national scale and to bid for funding from Europe. The research into the refinement of control methods on wintering sites, in particular using more staff and boats, led to a substantial increase in efficiency, particularly on larger wintering sites (i.e., those with a water surface greater than 1 km^2). Ruddy ducks are highly

visible, particularly in the autumn and winter, when very large numbers of birds congregate on known traditional sites. For example, in January 2000, 83% of the UK population was recorded on only 25 sites, with 67% occurring on only ten sites. This makes control easier and makes an estimate of the national population more accurate. The proportion of birds culled per visit on larger sites was 58% higher in 2003-2004 than during the Regional Control Trials. On smaller wintering sites, the proportion of birds culled was 18% higher. This significant increase in the efficiency of control operations resulted in a reduction in the predicted cost of an eradication programme of around 30%.

It has proved possible to cull between 20% and 60% (mean 41%) of ruddy ducks per visit on larger wintering sites, representing 50-110 birds per control visit in 2003-2004 (mean: 76 birds per control visit). On smaller wintering sites, the mean proportion culled per visit rises to 59% (up to 220 birds), while on breeding sites the mean proportion culled per visit is 47%.

Access has been allowed to a high proportion of sites, with 66% of site owners approached giving permission for control by shooting. More importantly, the owners of 37 of the 40 most important wintering sites in the UK have been approached in recent years, and 78% of these have given permission to shoot birds on their sites. This equates to access to over 80% of the UK wintering population. Analysis of count data shows that ruddy ducks move freely between sites in response to changes in weather conditions and as part of seasonal migration. This makes access to all sites unnecessary as it is highly likely that birds will occur at some point on sites where permission to carry out control has been granted. Between September and January, the range and number of sites holding birds is reduced as they move south and move from a larger number of smaller waters (typical of breeding and post-breeding sites) to a smaller number of larger ones (typical of wintering sites). The reverse pattern occurs in spring. It is also known that ruddy ducks move between sites in response to changes in winter weather conditions. During cold weather, birds move from smaller waters to larger ones, which are less likely to freeze over. Once milder conditions return, flocks of several hundred birds have been known to leave larger sites and to settle on other nearby waters. During the breeding season, movement between sites also occurs as a result of their mating strategy, when unattached males move between sites in search of females. As a consequence, access to all sites in an area is not essential to the programme.

Public reaction to control of ruddy ducks in the UK is mixed, but opposition has been much less than expected. Control has now been carried out on a wide range of sites across the UK, including areas where the subject is relatively emotive, such as the Western Midlands, an urban area where the regional bird club had the ruddy duck as its emblem species. Since 1999, only one control visit has been curtailed due to the presence of people opposed to the work. Only one visit has ever been cancelled as a precautionary measure – in 2001, when details of the time and location of a visit were passed to the local press.

Further refinement of the model has taken place to incorporate the new figures on control efficiency. This suggests that eradication from the UK is feasible as part of a five-year control programme. The mean time predicted to reduce the population to less than 50 individuals (i.e., by over 99%) is five years if eight staff are employed full-time for counts and control measures.

UK Eradication 2005-2010

In late 2005, funding was received from the European Union (EU) LIFE programme for the eradication of the ruddy duck from the UK. This source provided 50% of the costs required to undertake an eradication programme, matching funds being provided by the UK government. The objective of the project is to protect the European population of the globally-threatened white-headed duck from its most significant threat by eradicating the ruddy duck from the UK, and to exchange and disseminate information on control methods through contact with other European control teams and policy makers, leading to more effective control of ruddy ducks across Europe.

The specific actions and deliverables for this work are:

1. To remove the risk to the European population of the white-headed duck by carrying out control of the ruddy duck in the UK. Shooting will be the main method of control but others, including trapping and egg oiling, will be used as appropriate. Only cartridges containing lead-free shot and fibre wads will be used.
2. The collation of data on numbers of ruddy ducks being recorded on mainland Europe and in Spain in particular.
3. To monitor changes in the size and distribution of the UK ruddy duck population and to model the time and effort required for complete

eradication from the UK should this not be achieved within the timescale of the project.

4. To consult regularly with scientific advisors and animal welfare groups to ensure that disturbance to habitats and other species is minimised, that control and monitoring techniques are of the highest standard, and that best management practices are followed in terms of animal welfare.
5. To maintain contact with national control teams in other European countries and to disseminate best management practiced through exchange visits and workshops.
6. To raise public awareness of the need for control of the ruddy duck in order to prevent the effective extinction of the white-headed duck, with particular emphasis on site owners and other interested parties.

In the first 23 months of this programme a total of 3,637 birds have been removed.

CONCLUSION

The problem caused by ruddy ducks has been recognised since the early 1990s and a programme of method development, feasibility assessment, modelling, cost reduction, and now, eradication has been developed over this period. This will provide the UK's largest attempted eradication programme and the only one for a bird. It will also be the first European eradication programme involving coordinated efforts from multiple countries. The work has developed though a series of short– to medium–term funding, with over three years continuity in funding only achieved in the current EU LIFE project. Control of the UK ruddy duck population is proceeding well within the current 5 year programme, although full eradication will require the control of other European populations and the management of the existing captive stocks.

LITERATURE CITED

AMAT, J. A., AND SANCHEZ, A. 1982. Biologia y ecologia de la Malvasia *Oxyura leucocephala* en Andalucia. Donana Acta Vert. 9:251-320.

GOSLING, L. M., AND S. J. BAKER. 1989. The eradication of muskrats and coypus from Britain. Biological Journal of the Linnaean Society 38:39-51

GRAY, B. J. 1980 Reproduction, energetics and social structure of the ruddy duck. Ph.D. Dissertation, University of California, Davis, California, USA.

GREEN, A. J. AND B. HUGHES. 2001. Birds of the Western Palearctic update. Oxford University Press, United Kingdom 3:79-90.

HUGHES, B. 1996. The feasibility of control measures for North American russy duck *Oxyura jamaicensis* in the United Kingdom. Wildfowl and Wetlands Trust, Report to Department of the Environment, United Kingdom.

HUGHES, B., J. CRAIDO, S. DELANY, U. GALLO-ORSI, A. J. GREEN, M. GRUSSU, C. PERENNOU, AND J. A. TORRES. 1999. The status of the North American ruddy duck *Oxyura jamaicensis* in the Western Palearctic: towards an action plan for eradication 1999-2002. Council of Europe Publication T-PVS/Birds (99)9. Council of Europe Publishing, Strasbourg, France.

HUGHES, B., J. A. ROBINSON, A. J. GREEN, Z. W. D. LI, AND T. MUNDKUR. 2004. International single species action plan *Oxyura leucocephala*. WWT Report to Birdlife International.

MCCRACKEN, K. G., J. HARSHMAN, M. D. SORENSEN, AND K. P. JOHNSON. 2000. Are ruddy ducks and white-headed ducks the same species? British Birds 93:396-398.

SMITH, G., I. HENDERSON, AND P. A. ROBERTSON. 2005. A model of ruddy duck *Oxyura jamaicensis* eradication for the United Kingdom. Journal of Applied Ecology 42:546-555.

TORRES, L. A., C. RAYA, J. M. AYALA, AND J. M. MORENO. 1985. Estudio del compartmiento reproduction de la Malvasia *Oxyura leucocephala*. Oxyura 2:5-22.

WETLANDS ADVISORY SERVICE. 2002. The winter status and distribution of ruddy ducks in the UK, 1966/1967-1999/2000. Report to the Department for Environment, Food and Rural Affairs, United Kingdom.

WETLANDS INTERNATIONAL. 2002. Waterbird population estimates. 3rd Edition. Wetlands International. Global Series No 12. Wageningen, Netherland.